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NEUROHISTOLOGICAL STUDY OF SYMPATHETIC GANGLIA IN THROMBOANGITIS OBLITERANS WITH SOME CONTRIBUTIONS TO ITS PATHOGENESIS

by

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I INTRODUCTION

For a long time there have been various opinions about the pathogenesis of arteriopathy which causes thromboangitis obliterans, but no definite one has yet been settled on. However, through a theory of angitis which was advocated by WINIWARTER, and supported by the research of BUERGER, ISHIKAWA and others, the theory of angitis (artery as well as vein) has recently become the most prominent. Although there are various theories concerning the factors which cause angitis, none of them has been verified yet. Among those factors the participation of the autonomic nerve system is a conceivable one and is supported by the STÖHR, while HERZOG and CRAIG deny it. Here we have some opinions on the pathogenesis of this disease obtained through histological examinations of the sympathetic ganglia resected from the patients concerned.

II MATERIALS AND METHODS

The materials used were sympathetic ganglia of lumbar region resected by operation, from male patients of thromboangitis obliterans between 20-40 years of age. After the operation, the ganglia were immediately fixed in a 20% neutral formalin solution, and frozen in slices of 20-40μ in thickness. After being kept in 10% neutral formalin solution for more than 2 weeks, these slices were stained, some by SUZUKI's modification of BIELSCHOWSKY's silver impregnating method, and others by the acid-haematoxylin staining method.

III NEUROHISTOLOGICAL OBSERVATIONS

In the nerve elements of the resected sympathetic ganglia, various pathological observations were obtained. They are classified and dealt with as follows:

a) Changes in the nerve cells.

Nerve cell observations were made on the swelling of cells, the vacuolation, the atrophy, the destruction of fibrils, the hyperchromatic, the pigmentation, and the lobulation. Concerning the swelling of cells, each became, as a whole, lightly chromatic, and its contour was an irregular circle. The fibrils were rough, and slightly argyrophilic (or poorly stained) spaces could be seen in several places. Being few in

number, the vacuoles were seen as circular spaces with sharp contours: this was assumed to be the vacuolation that HERMANN mentioned. Regarding the atrophy of cells the hyperchromatic of the cells was in general slight with some degrees of concentrations, and, at their periphery, defects of the neurofibrils were seen in strip with atrophic figures of the nuclei. These defects appeared to be large and irregular in form and distinctly different from the vacuoles. Concerning the hyperchromatic, it was found that the cells were stained fast and deep. Concerning the pigmentation, slightly argyrophilic granules were found in the preparations made by the silver impregnating method and yellowish brown ones were obtained by staining with acid-haematoxylin. As for the lobulation of nerve cell, its lobular state with swollen nerve roots in common protoplasm was found, then it was supposed to be the lobulation as HERMANN had described.

b) Observations on the nerve cell nuclei.

The following observation will be mentioned, viz. the hyperchromatic of the cell nuclei, the deviation, the karyolysis, the nuclear membrane hypertrophy, and the multinucleate cell. Concerning the hyperchromatic of nuclei, they might be stained deeper than their cells. As to the deviation of nuclei, they were generally found positioned toward the periphery of their cells, or were in protrusion. In the deviated nuclei, the nuclear chromaffinity, as a whole, was light and a part of it had vanished already. Moreover, the shape of the nucleus was an irregular circle. As for the nuclear membrane hypertrophy, it was found that all margins of the nuclei were stained fast and appeared in a dark ring. Regarding the multinucleate cell, two nuclei in a cell were found, but no cells with three nuclei.

c) Observations on the nerve process.

Concerning the nerve process the following changes were seen, viz. disharmony of the nerve process indicating increase in number, i. e. hyperplasia, and in size, i. e. hypertrophy, decrease of the nerve process, vacuolation in the process, pericellular glomerular body of the fibrils (Faserkorb), Globule-phenomenon (Kugelphänomen), hollow cylinder processes and the appearance of fenestration between the protoplasm and the process. STÖHR called the increase in number and in size of the nerve process as disharmony and asserted that it was an important characteristic of the nerve cell degeneration. However, according to our observation, this change was appeared in about 41.7% of degenerated cases. The hypertrophy of the nerve process refers to the increase of the diameter. Yet there was not only an increase of the diameter, but also in certain cases, the arrangement of fibrils in the process became unequal; some parts became rough, and some, thick; and defects of fibrils appeared in some processes. These defects of fibrils sometimes resembled vacuoles in the process, and in the sectioned figure, in some cases, the nerve fibrils gathered on the surface of the process, and gave the appearance of a hollow cylinder i. e. Hohlzylinder or Federkiel (HERZOG). Moreover, under certain circumstances, a defect of fibrils in the process near the nerve cell would become huge, and the cell degeneration by lobulation of the nerve cell mentioned above could be seen. Nerve cells, which had remarkably fewer number of processes than the normal nerve cell, were observed. And some,

which in contrast to the above mentioned, had an increased number of the nerve processes, which were arranged radiately from the atrophied cells to their circumference (Caput medusae). In about 8.2% of the nerve cells, small fibrils proliferating on the circumference of the cell became reticular and packed in dense group, which were called pericellular glomerular bodies of the nerve cell fibers.

The point of the dendrites was magnified in section and found to be hypertrophied. This is called LAWRENTJEW's globular phenomenon. The points of some dendrites were found here and there to be ring in form. Dendrites which were branched small and thin, were found sticking to the nerve cells like palps (Bartbildung). Anastomosis occurred among the short dendrites and the surrounded areas were like windows in appearance. This kind of cells are called fenestrated cells and in sympathetic ganglia they are considered as a pathological figure. The fenestrated cells were carefully distinguished with cell vacuoles.

d) Satellite cells.

In cases where various degenerations were found in the nerve cells and nerve processes as stated above, proliferation of the capsule cells was found, and the protoplasm of the nerve cell phagocytosed some of the capsule cell nuclei. This is called phagocytosis of the nerve cell and some nerve cells are replaced by the proliferated capsule cell, as the result of phagocytosis, is so called TERPLAN'S body (satellitosis).

Table 1 Number of the degenerated Cells with each Cases and its Ratio.

Case Number	Degeneration															Total	Normal Cells	Degenerated Cells Ratio
	d_1	d_2	d_3	d_4	d_5	d_6	d_7	d_8	d_9	d_{10}	d_{11}	d_{12}	d_{13}	d_{14}	d_{15}			
1	4	11	2	6	7	0	0	0	34	11	7	11	0	0	1	95	5	95%
2	2	19	0	0	4	1	1	0	20	3	5	3	1	1	1	61	39	61%
3	1	7	0	1	6	1	0	1	41	7	4	8	0	0	1	88	12	88%
4	1	16	1	1	11	0	0	0	27	19	3	2	1	1	0	83	17	83%
5	0	7	4	0	9	0	0	0	45	6	2	4	0	0	0	77	23	77%
6	0	4	2	0	13	0	0	0	40	11	3	3	0	0	0	76	24	76%
7	3	11	4	1	8	0	0	0	53	5	4	2	0	0	1	92	8	92%
8	6	3	1	0	3	4	2	0	39	7	19	6	0	0	0	90	10	90%
9	5	4	0	0	2	0	0	0	44	10	13	4	0	0	0	82	18	82%
10	7	2	0	0	0	2	1	0	49	8	1	3	2	0	0	75	25	75%
11	11	1	0	0	8	1	1	1	31	11	19	5	1	0	0	90	10	90%
12	7	6	0	4	13	0	1	0	29	0	11	6	0	0	1	78	22	78%
13	12	2	1	3	9	1	0	0	21	2	13	24	2	1	1	92	8	92%
14	8	2	2	1	18	11	1	0	19	11	8	16	0	0	1	98	2	98%
Total	67	95	17	17	111	21	7	2	492	111	112	97	7	3	7	1177	223	84%

d_1- Vacuolation.
d_2- Deviation of nucleus.
d_3- Pyknosis.
d_4- Nucleus membrane hypertrophy.
d_6- Karyolysis.
d_6- Swelling of cytoplasm.
d_7- Pigmentation.
d_8- Atrophy of cytoplasm.
d_9- Disharmony of nerve process.
d_{10}- Hypertrophy of nerve process.
d_{11}- Fenestrated cells.
d_{12}- Pericellular glomerular body of fiber.
d_{13}- Lobulation.
d_{14}- Globular phenomenon.
d_{15}- Ring-like formation.

Table 2 Ratio of the degenerated Cells in every Case.

Case Number	Degeneration														
	d_1	d_2	d_3	d_4	d_5	d_6	d_7	d_8	d_9	d_{10}	d_{11}	d_{12}	d_{13}	d_{14}	d_{15}
1	4.2	11.6	2.1	6.3	7.4	0	0	0	35.3	11.6	7.4	11.6	0	0	1.1
2	3.3	31.2	0	0	6.5	1.6	1.6	0	32.8	4.9	8.2	4.9	1.6	1.6	1.6
3	1.4	21.6	0	0	4.8	1.1	0	1.1	22.7	3.4	5.7	3.4	1.1	1.1	1.1
4	1.2	9.6	1.2	1.2	13.5	0	0	0	32.6	22.9	3.7	2.4	1.2	1.2	0
5	0	9.1	5.2	0	2.5	0	0	0	55.7	7.8	2.6	5.2	0	0	0
6	0	4.3	2.6	0	17.1	0	0	0	55.2	14.5	3.9	3.9	0	0	0
7	3.3	11.9	4.3	1.1	8.7	0	0	0	55.1	5.5	4.7	2.2	0	0	1.1
8	6.3	3.3	1.1	0	3.3	4.4	2.2	0	43.7	7.8	21.9	6.6	0	0	0
9	6.1	4.9	0	0	2.4	0	0	0	53.4	12.2	15.9	4.9	0	0	0
10	9.5	2.7	0	0	0	2.7	1.3	0	65.1	10.7	1.3	4.0	2.7	0	0
11	12.2	1.1	0	0	8.8	1.1	1.1	1.1	34.4	12.2	21.6	5.5	1.1	0	0
12	8.9	7.7	0	5.2	16.6	0	1.3	0	37.1	0	14.1	7.7	0	0	1.3
13	13.4	2.2	1.1	3.3	9.8	1.1	0	0	22.8	2.2	14.1	26.4	2.2	1.1	1.1
14	8.2	2.0	2.0	1.0	18.4	11.0	1.0	0	19.4	11.2	8.2	16.3	0	0	1.0
Total	5.7	8.1	1.4	1.4	8.6	1.8	0.6	0.1	41.7	8.6	8.6	8.2	0.6	0.16	0.42

The degenerative cells appeared in the rate as shown in the following table (Tab. I and II).

IV DISCUSSION

As the pathogenesis of the arteriopathy which causes thromboangitis obliterans, many factors have been considered; arteriosclerosis, thromboangitis, angiospasm, syphilis and others. Above all, the theory of angitis became the leading one through the research made by WINIWARTER (1879) and BUERGER (1908), and the arteriopathy has been called Endangitis obliterans (WINIWARTER) or Thromboangitis obliterans (BUERGER). The pathologic change of the blood vessels in the present case agrees with angitis, though admittedly, the pathogenesis does not successfully explain unitarily the role of all the factors which are regarded to have an intimate relation with this disease, age, race, nicotinism, allergy, collagene disease, non-suppurative infection.

Each blood vessel is controlled by the strong yet delicate autonomic nerves as well as the afferents, and the functional disturbance of the nerves may cause the pathologic reaction of blood vessel. The participation of the autonomic nerve in BUERGER's disease has been supposed for a long time. Having examined the resected sympathetic ganglia neurohistologically and confirming the complicated changes, HAGEN, STÖHR, KUNTZ, FEYRTER, SUNDER-PLASSMANN and RICHTER advocated that the change in the sympathetic ganglia is the root of the disease. However CRAIG and KERNOHAN, ORIA and SKOOG drew from their histological observations a different conclusion which is being supported by HERZOG.

Preparatory to the present study on the materials to be examined, we were

cautious in the following points. The figures of the nerve cells show a wide physiologic variation and we have often difficulty in deciding whether it is healthy or not. That is, it is said that a nerve cell can change the appearance in its life, and the degenerative nerve cell always exists at all ages.

Generally the ratio of degenerative cells increases in the old age. Having considered this point, HERMANN described the numerical ratio of the degenerative nerve cells to all nerve cells in the peripheral ganglia, by which a line could be drawn between the healthy and pathologic, young and old, and that a correct diagnosis of pathologic ganglia might be given by it. According to his opinion, the maximum of physiological ratio of degenerative cells in various ages is 12%. For example, when the ratio is 5-6% the ganglia are evidently healthy, while they are pathologic when the ratio is 80-90%. However, it is difficult to make a decision when the ratio is 30-50%; without considering other factors. The morphological difference between physiological and pathological degenerative cells, was not detected by him. Whether they appeared due to age or to pathologic cause, should be separated and strictly distinguished. However, the distinction of these two is as difficult as that of health and unhealth, and young and old cells. Therefore, though HERMANN's conception of numerical expression seems quite reasonable and beyond doubt, yet it is difficult to give a full explanation on the physiological or pathological condition of the ganglia only from the ratio of degenerative cells. From the histological point of view, certain degenerative figures and frequency of their appearance associated with the individual and age difference have been seen in other diseases, too. Some degeneration process may be temporary and reversible. Thus, the appearance ratio of degenerative cells differs according to the time and conditions when the material was obtained. For that reason the author not only attempted a numerical expression, but he concentrated on the research of the morphological changes which can be recognized as pathologic degeneration with fair certainty.

SPIELMEYER mentioned the swelling of cells as one of the pathologic changes of nerve cells; generally acute hypertrophy was observed in the central nerves, yet DE CASTRO and LAWRENTJEW found it in the sympathetic ganglia when they cut the postganglionic nerve. It is believed that acute change accompanies tygrolysis and deviation of nuclei, that there is no change in the nerve fibrils and the nuclei themselves, and that this is a kind of reversible and excited state. The swelling of cells observed in our preparations showed irreversible degeneration figures, and the deviated nuclei, being extreme, sometimes protruded to the cell margin, or the nucleus became concentrated, and the fibril construction, becoming irregular, occasionally broke down into granulation. Moreover the argyrophilia of each swelled cell decreased frequently and the cell gave an alveolate or a lobular appearance.

The nerve processes also swelled up and some had an alveolate form, which was considered to be the lobulation (Lappung) described by HERMANN. When a cell swelled, the satellite cell nucleus which adhered to the swelled cell, lost its normal form and became flat. Again in contrast to this, nerve cells whose nerve processes decreased or vanished with the swelling of the cells, could be seen. The above

mentioned observation was considered to be pathologic. Cell swelling, on the other hand, could be seen as cell atrophy. It is sometimes difficult to distinguish the atrophic nerve cell from the small nerve cell, however in the case of pathologic atrophy other degeneration factors, for example the nucleus change or the change of fibrils, was accompanied. Occasionally the cell not only atrophied intensely, but also lost its argyrophilia and left a faint cell trace; processes appeared in remarkable radiate arrangement. An appearance of the caput medusae could be seen in large number. This was first described by HAGEN as a simple degenerative figure, but the present author considers that the caput medusae must be due to pathologic factors which first produced an stimulated state and then atrophic change. In the specimen impregnated with silver there appeared two kinds of change of the nerve cells. One was an increased argyloaffinity of the nerve cell and another was fragmentation of neurofibrils occurred in the nerve cell which resulted in fibril destruction. These two kinds of figure were observed frequently, but were hardly considered as pathologic unless they coexisted with other degenerative phenomenon.

The vacuoles in the cells showed various appearances depending on their size, number and location. Very often we found it difficult to distinguish whether it was a vacuole in the cell, a vacuole in the satellite cell layer or an extracellular space caused by the atrophic shrinkage of cell body, whether it was pathologic or not; or if it was an artificial product. In order to decide it as a pathologic vacuole in the cell, other sign in the cell must be noted.

The nucleus of the sympathetic ganglion cell always locates more or less eccentrically, but when the eccentricity becomes extreme and closely approaches the cell margin, or appears to be protruded from the cell margin, it should be considered surely as pathologic. MÜLLER, FEYRTER, STIEVE, ARAKI and INOUE, laid stress on the eccentric location of the nucleus as a pathologic sign. Its reversibility, when it is slight, was verified by STIEVE by experiment. Eccentric nuclear location in extreme degree may be considered pathologic without other degeneraitve phenomenon.

The change in the nerve processes is one of the remarkable changes of the nerve cell, and has long been studied by a number of scholars. The number of processes out of a normal nerve cell was fairly unfixed and better to consider it variable. Some authors oppose the opinion that changes in the process have pathologic significance because of their existence in physiologic state or in the old age. However, we think the some forms of them to be pathologic. The increase in number of processes is called the hyperplasia of the processes, and the increase in size, the hypertrophy, but both appear combined and is called by STÖHR as Fortsatzdisharmonie. This was one observed most frequently in our preparations. The beard-formation (Bartbildung) and the medusa head of the nerve cell could be considered atypical hyperplastic process. STÖHR accepted this change as primary degeneration, but according to our views there was primarily an stimulated state before the secondary degeneration process. In contrast to the above mentioned stimulated proliferation, some nerve cells lost the nerve process when the nerve cells swelled intensely.

Some changes, equivalent to the swelling, liquefaction and alveolate degeneration

in the nerve cells, could be observed in the nerve process. One of them is called edema of the dendrites or vacuole (STÖHR), in which tuberous hypertrophy could be seen in places and contains rough reticular structure. Sometimes it has a spherical or irregular shape. When it appeared near the cell, it was difficult to identify whether the change was in the cell or in the process. With the homogenous swelling and hypertrophy of the process the fibrils became dense at the surface in the section of the nerve process, and gave the appearance of a hollow cylinder on the plane which is known as a hollow cylinder of a quill pen (Hohlzylinder or Federkiel). We understand these observations as pathologic, and frequently we observed them in the ganglion of the disease concerned. Globular phenomenon (Kugelphänomen-LAWRENTJEW) have been known since CAJAL as the spherical hypertrophy of the point of the dendrites. DE CASTRO made an observation on its appearance with transplanted nerve cells. This phenomenon is considered to be analogous as the formation of an amputation neuroma or a contracted spheroid, but not an artificial product (CAJAL, LAWRENTJEW, HERZOG). This is known in disk or loop form, but when observing one should be sure that it belongs to the dendrits. The reason is that the ends of preganglionic fiber rarely appear in this form.

The pericellular globular body of the fiber (so called Faserkorb) is also a well known phenomenon first described by CAJAL as being pathologic. This kind of degeneration was also met with frequently. It is a fiber mass tissue surrounding a nerve cell, sometimes having its origin at the ends of the preganglionic fibers. However, there are also some found in the experiment of the nerve cell transplantation and postganglionic amputation of the nerve fiber (such as DE CASTRO's). From these facts STÖHR considers that the pericellular globular body of the fiber is produced from the neurites or, dendrites or the satellite cells. Since their connection with the nerve process was not clear, they might be the products of the satellite cell. ONO, KOIDE and INOUE considered that the nerve cells in the center of the pericellular glomerular body had some degenerative appearance, and this pericellular fiber body was the reaction of the satellite cell layers accompanied by the cell degeneration. Therefore, this fiber, as STÖHR and others described, was not neurofibrils but gliafibrils produced from the gliocytes of the satellite cells.

In normal spinal ganglia, the fenestrated cells are not so rare and they may also be seen here and there in normal sympathetic ganglia. We also meet with them in the sympathetic ganglia of our specimens and YAMANOUCHI had been observed them in the AUERBACH's plexus of the stomach in the case of gastroptosis. This figure is found in the peripheral area of a cell body or protruded from its margin, and the fibril in the cell and brief process participate in its formation. Sometimes it is difficult to distinguish it from a vacuole. When there is no other sign of degenerative symptoms, it is better not to judge it as pathologic one.

The neuronophagia is according to BIELSCHOWSKY and SPIELMYER, a phenomenon caused by the satellite cell which enters into the degenerating nerve cell. This phenomenon has long been known as a pathologic degeneration of the central nerve system, and HERZOG, CRAIG and KUNTZ have noticed this in the sympathetic ganglion.

In the histological figure, the ganglion cell phagocytosis means the satellite cells falling into the degenerated cells. Care should be taken in judging this as the ganglion cell phagocytosis. That is, the phenomenon accompanies more or less proliferation of satellite cell layers. In some specimen, when the satellite cell increases, some section may give an appearance of nerve cell phagocytosis with the overlapping figure of the nerve cells and the satellite cells. The so called TERPLAN'S body, the congregated satellite cell nuclei, has the same relation with a nerve cell. At least a satellite cell nucleus group without having any relation with the nerve cell should be understood better as the proliferation of the gliocytes to fill the deficit of the destructed nerve cell (neuronocytolysis-HERZOG) rather than the ganglion cell phogocytosis.

The view that the nerve cell and its satellite cells are unseparable functional unity was advacated by CAJAL, and has been supported by DE CASTRO, BIELSCHOWSKY, HERZOG and STÖHR. When the degeneration occurs in nerve cells, the satellite cells also show the flattening, swelling and the destruction of their nuclei, as well as atrophy and vacuolation of the cell bodies. On the other hand, a remarkable reactive proliferation of the satellite cells can be seen. This phenomenon appears in the apparent ganglion cell phagocytosis or in TERPLAN'S body. The satellite cell group in the destroyed area of the nerve cell, as NAGEOTTE had described, is correctly called residual nodules (nodules residueles).

In the case of the proliferation of the satellite cells, a fibril mass is often formed simultaneously, but they are not always parallel. The fibril mass, when arranged so as to surround a nerve cell, is called pericellular glomerular body of the nerve fiber (Faserkorb). Regarding the origin of this fibril, HERZOG described it as a product of the nerve cell and the nerve process stimulated by the satellite cell. KOIDE, ONO, INOUE and others think it is newly grown glia fibers out of the satellite cell.

Multinucleate ganglion cells:

They are found occasionally in the spinal ganglia of newly born and children, and in the plexus prostaticus and seminalis of adults. Those in the sympathetic ganglia of adults can be considered as pathologic, and these multinucleate cell are based on amitosis. We also observed many examples of the sympathetic ganglia of our cases, yet the finding was not so large in number.

The degenerative change in the resected sympathetic ganglia in the example of BUERGER'S disease was described as above. The nature and quantity of the change agree with the opinion of STÖHR, HAGEN, ABRAHAM, FEYRTER and SUNDER-PLASSMANN. CRAIG and KERNOHAN examined thromboangitis obliterans, RAYNAUD'S disease, scleroderma by the histological examination on the resected sympathetic ganglia of arthritis. They observed the proliferation, the vacuolation and the cystoma formation with mucine of satellite cell layer but they did not observe the change of the nerve cell. They made a conclusion that it was difficult to find any difference between these changes and the control. They were the changes of age or in physiologic limit, and were not enough to be considered to cause the disturbance of the peripheral blood circulation. And, having presumed that the cause of circulatory disturbance should

be in higher center, they supposed the improvement in the blood circulation by the sympathetic ganlionectomy as the interception of pathologic impulsion from the higher center. We had no material to discuss concerning the degeneration in higher center. GAGEL and WATTS did not observe the change in the sympathetic ganglia of a case of RAYNAUD's desease, yet they observed the degeneration in the spinal lateral column.

HERZOG opposed in presenting degenerative character on the change in the ganglia, because it is due to age and reversible. With the silver impregnating method and the NISSLE staining, ENGELBRECHT found 17 kinds of the pathologic pattern of the sympathetic ganglion cell, and diagnosed that a nerve cell having more than two pathologic signs was the pathologic nerve cell. He examined the resected sympathetic ganglia in BUERGERS disease and found 33.5-72.4% pathologic degenerative cells. HERMANN described coronalsklerosis, RAYNAUD's disease, endangits obliterans, skleroderma, lichen ruber planus and hypertension as the disease which have numerical pathologic degenerative nerve cells. Here we are not going to discuss the observation of the sympathetic ganglia cell in RAYNAUD's disease, but we think the tonic contraction in the limbs of the arteries and the arterioles is its true form. The beginning of the disease lacks organic change in the vascular wall, and at the end of it, appears organic change like thromboangitis. LEWIS advocates the theory of hypersensitiveness of smooth muscle of the blood vessel as its pathogenesis, but most people admit it to be due to the disharmonious vasomotor nerve (WHITE, SMITHWICK and others). According to the latter opinion, the vasomotor nerve is disharmonious or in sensitized state, and arterial spasm first occurs in wet and cold and by overstrain of extremities, nicotine and other factors, and then the hypertrophy of the internal membrane and thrombosis is set up there. MORIKAWA confirmed the development of nerve fibers in the regenerated arterial wall after the artificial thrombosis, which meant proliferation of the collateral vessel accompanied the nerve regeneration. The same nerve regeneration may be occured in the pathologic arteries as well as the collateral ones in thromboangitis which suggests participation of the nerve factor in this disease. HACHISUKA examined the blood vessel wall of this case histologically and found the degenerated terminal reticulum with the degenerated or regenerated nerve fiber. He considered that the nerve fiber degeneration was the secondary change following the change of the blood vessel wall and supposed that the regenerated nerves in the pathologic blood vessel cause the reflex angiospasm. He agreed with the participation of the nerve elements in the pathogenesis of this case.

The neuropathological observation we obtained is markedly different from that of ORIA, SKOOG, CRAIG, KERNOHAN and RIEDER in nature and quantity, and rather agrees with the opinions described by SUNDER-PLASSMANN, RICHTER, STÖHR, SCHMITZ, HAGEN, FEYRTER, MEYER and WAALER & GLUCK in considering the change of the nerve elements to be the pathologic degenerative character. Even though most part of its degeneration of the nerve elements in the sympathetic trunk was supposed to be the change of age, it could not be thought that the marked degeneration had no influence to the peripheral circulation. The blood vessel of the lower extremities is innervated segmentarily by the sympathetic postganglionic fiber which accompanied

with the spinal nerve.

We do not deny the degeneration in the center higher than the sympathetic ganglia, but we can hardly approve the opinion that the changes of the sympathetic ganglia in our observation to be nothing but physiological and of age. Moreover, we could not determine whether the degenerated figures were of the primary or the secondary changes. In these changes, for instance the swelling of the cell and the proliferative change of the nerve process show the activation of the peripheral vascular contraction. The existance of this degenerative cell may not only variate the impulsion from the higher center but also give influence to the peripheral blood circulation, and can be the factor aggravating this case.

V SUMMARY

Through the neurohistological examination on the sympathetic ganglia resected from the patients of thrombangitis obliterans, the following findings were obtained.

1) In almost 84% of the examined nerve cells in the sympathetic ganglia of the lumbar region pathologic degeneration was observed.

2) Concerning the ganglion cell protoplasm.

The swelling, the vacuolation, the atrophy, the destruction of the fibrils, the hyperchromatic, the pigmentation and the lobulation of the cells were observed.

3) Concerning the nerve cell nucleus.

The hyperchromatic, the deviation, the concentration, the karyolysis, the nuclear membrane hypertrophy and the multinucleate were observed.

4) Concerning the nerve process.

The disharmony (hyperplasia and hypertrophy), the atrophy, the decrease, the vacuolation, the pericellular glomerular body, the globular phenomenon, the hollow cylinder formation, the new growth of the auxiliary processes and the appearance of the fenestration between the cell protoplasm and the processes were observed.

5) Concerning the satellite cell group.

The proliferation of the satellite cells, the appearance of Terplan's body and the phagocytosis or neuronocytolysis of the ganglion cells were observed.

6) The above-mentioned observations on the degeneration of the various nerve elements should not be considered as the degeneration of age and in physiological limit, but they are presumed to play a role in the pathogenesis of this disease.

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和 文 抄 録

特発性脱疽に於ける交感神経節の病理組織学的研究並びにその病因に関する知見補遺

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平 光 圭 夫

Bielschowsky 氏鍍銀法の鈴木氏変法と，酸ヘマトキシリン染色を用い，特発性脱疽患者から切除した交感神経節(主として腰部交感神経節)を組織学的に検査し，併せてその所見から特発性脱疽の病因について考察を加え，次の結論を得た．

1) 被検腰部交感神経節の神経細胞の約84%において病的変化を来している所見を認めた．

2) 神経節細胞の変化としては，細胞体の腫脹，空胞形成，萎縮，原線維破壊，過染性，色素沈着及び分葉化であつた．

3) 神経核には，細胞核の過染性，偏位，濃縮，融解，核膜肥厚，多核性が認められた．

4) 神経突起には，突起失調（増殖，肥厚），萎縮，減少，空胞形成，細線維形成，球現象，空筒形成，副突起新生並びに突起による有窓細胞出現が認められた．

5) 神経外套細胞合胞体では，外套細胞増殖，テルブラン氏体出現及び神経節細胞喰食が認められた．

6) 上記のような交感神経節における種々な神経要素の変性所見は単なる年令的，生理的変化と考うべきものではなく，本症に対して因果関係を有するものと推定されるものである．

Fig. 1 Atrophia of the cytoplasm, Terplans body-like increasing of the satellite cell. × 400

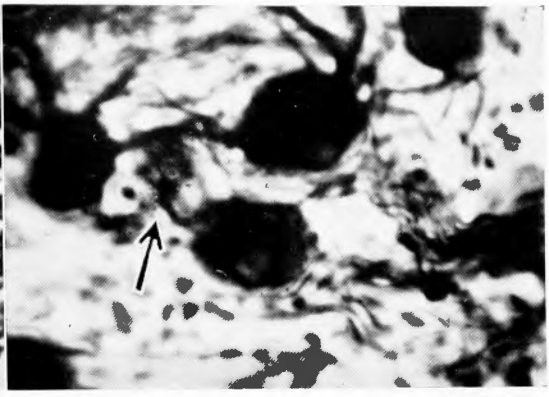

Fig. 2 Nerve cells in a ganglion showing the hypertrophia of the nerve process and the lobulation of process with a vacuole. × 400

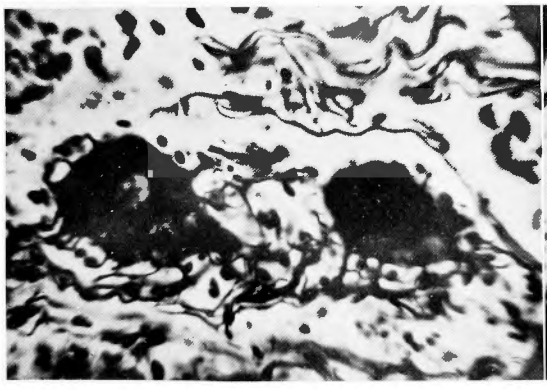

Fig. 3 A degenerated nerve cell showing disharmonious growth of nerve process, and fenestrated ganglion cell are observed. × 400

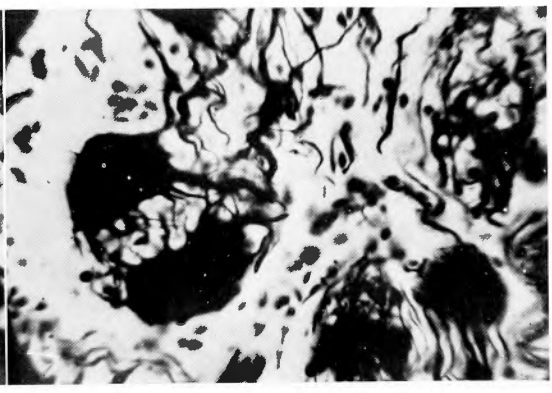

Fig. 4 Hypertrophic and hyperplastic nerve process. × 400

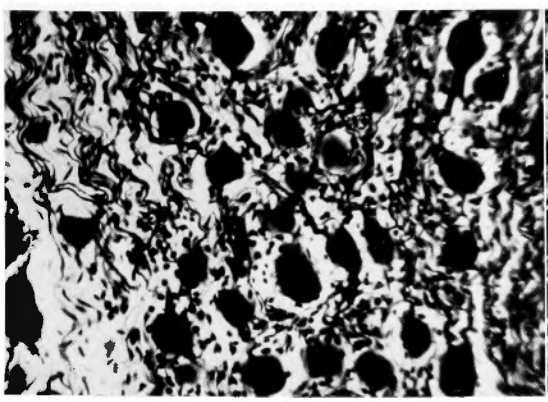

Fig. 5 Irregular form of the ganglionic cell with proliferation of the satellite cell layer. × 200

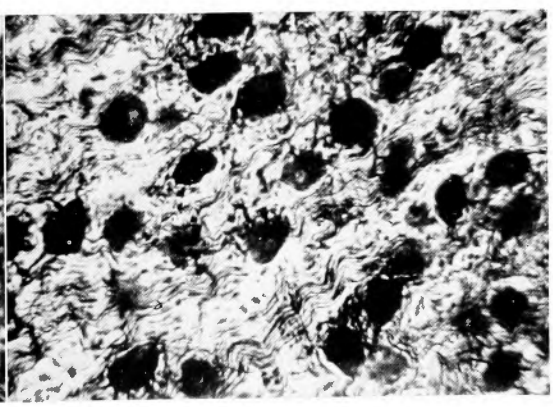

Fig. 6 Degenerated ganglionic cells, and disharmonious growth of the nerve processes. × 200

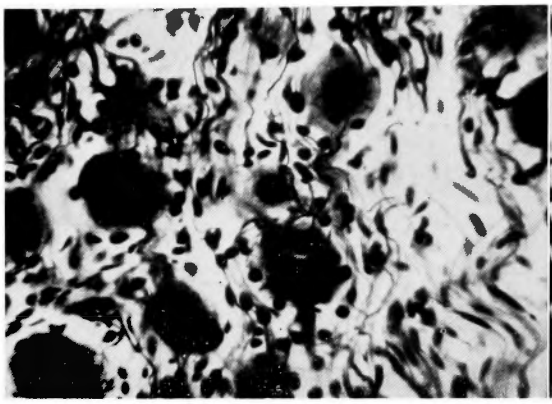

Fig. 7 Hyperplastic satellite cell layer and neuronophagia or neuronocytolysis. × 400

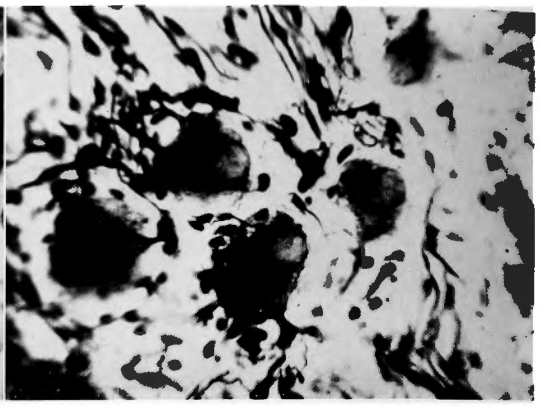

Fig. 8 A degenerated nerve cell showing the nuclear deviation, the hypertrophia of the nuclear membrane and disharmonious growth of nerve process × 400

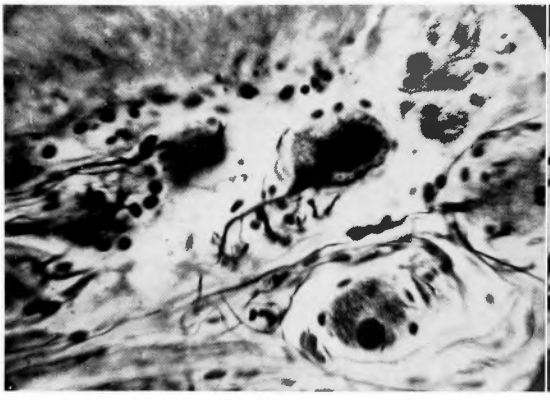

Fig. 9 A rough structure of neurofibril in protoplasm, and deeply stained perinuclear zone. × 400

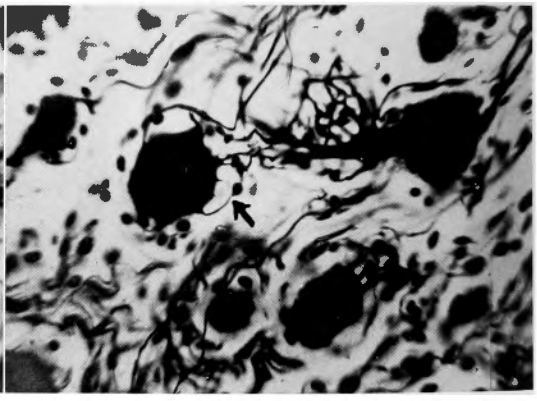

Fig. 10 Fenestrated ganglionic cells with disharmonious growth of the nerve process. × 400

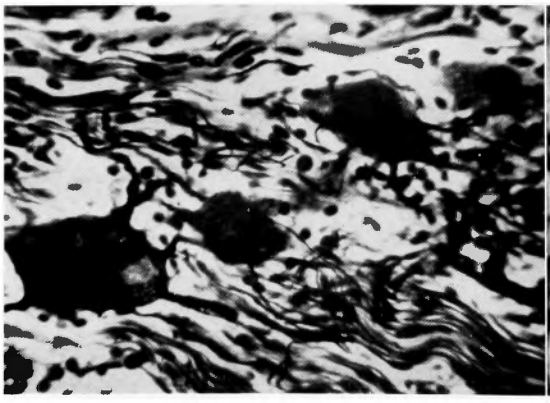

Fig. 11 Irregular-formed nerve cells in a ganglion are attended with a large vacuole in the cytoplasm. × 400

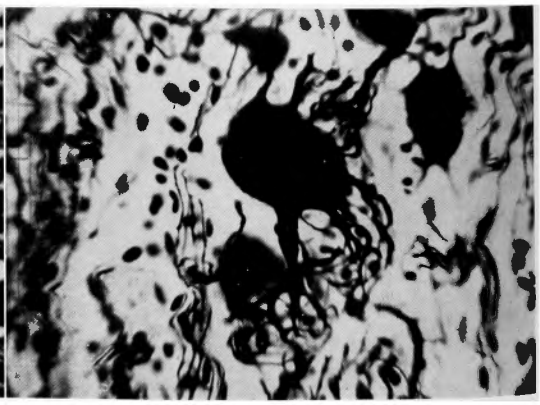

Fig. 12 Fenestrated cell with vacuolation and hypertrophia of the nerve process. × 400

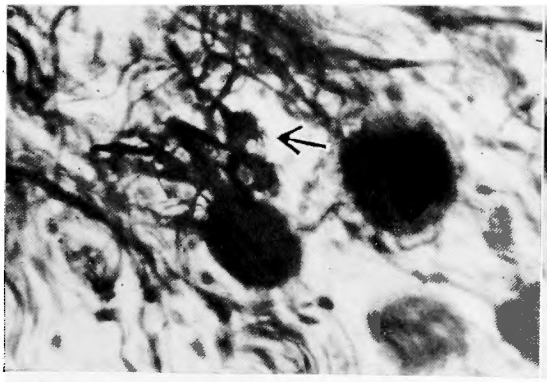

Fig. 13 Beard-like formation (Bartbildung) of the nerve process, and pericellular glomerular body (Faserkorb) are observed. × 400

Fig. 14 Fenestrated ganglionic cell and the disharmony of the nerve process. × 1,000

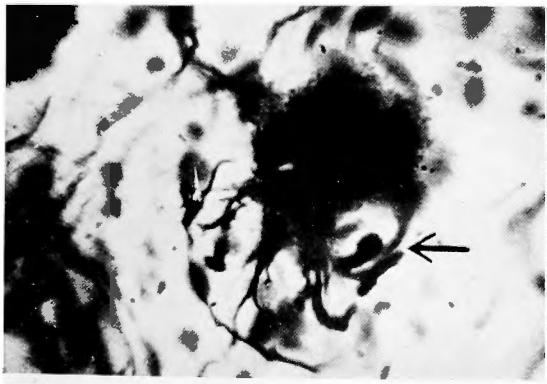

Fig. 15 The globular phenomenon (Kugelphänomen) at the point of the nerve process, and disharmony of the nerve process. × 1,000

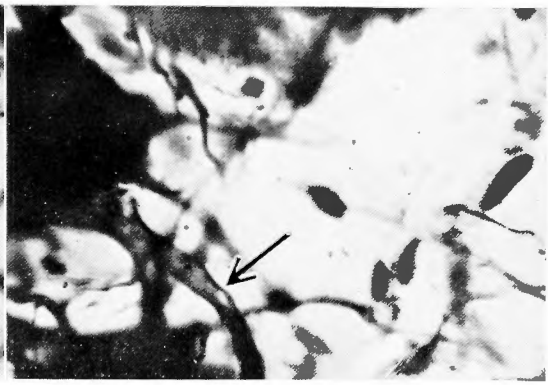

Fig. 16 Swelling and vacuolation of the nerve process. × 1,000

Fig. 17 Disharmonious growth of the nerve process, and proliferation of the satellite cells. × 400

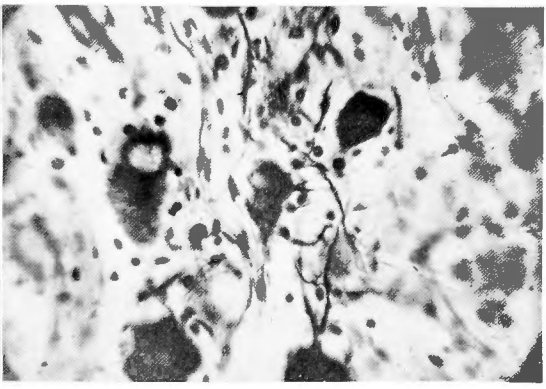

Fig. 18 Degenerated ganglionic cell shows a karyolysis, and appearance of the binucleated cell is observed. × 400

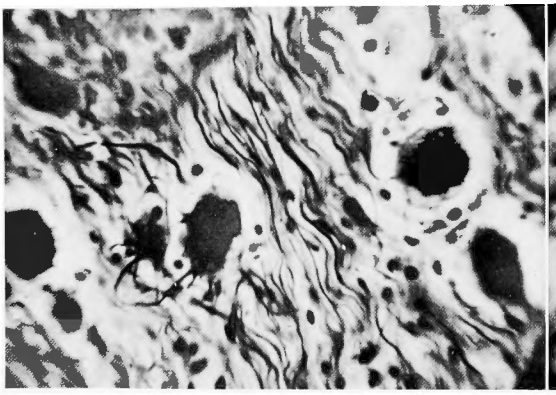

Fig. 19 Destruction of neurofibril in the ganglionic cell protoplasm. × 400

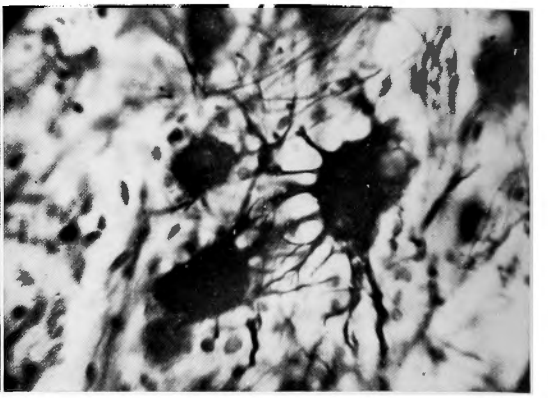

Fig. 20 Irregular-form of the ganglionic cell with hypertrophic nerve processes, and vacuolation in the cytoplasm. × 400

Fig. 21 Ring-like formation at point of the process, hollow cylinder (Hohlzylinder) of the process are observed. × 1,000

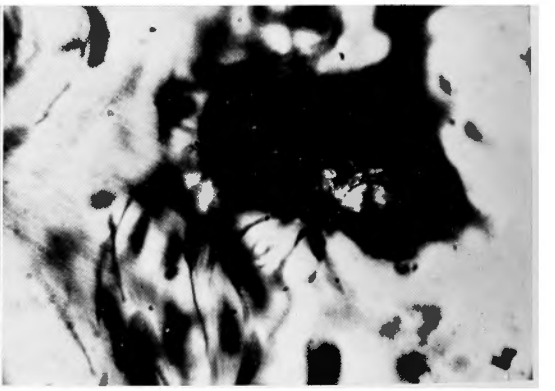

Fig. 22 Nuclear atrophy and disharmony of the nerve processes. × 1,000

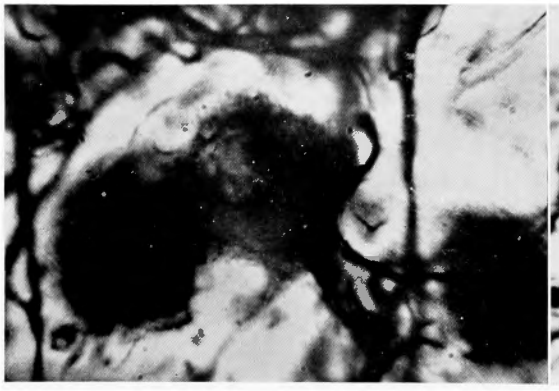

Fig. 23 An irregular formed ganglionic cell with lobulation of the cytoplasm and its process enlarged. × 1,000

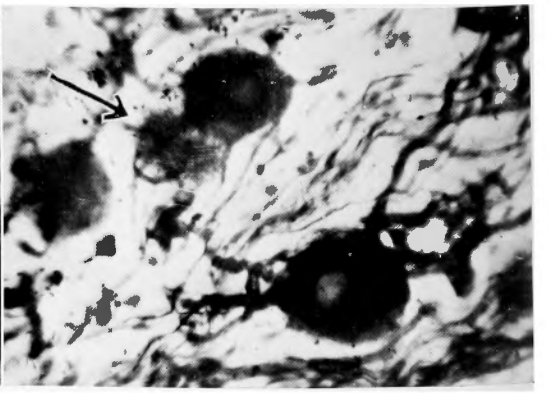

Fig. 24 Pericellular glomerular body of fiber (Faserkorb) and hypertrophia of nuclear membrane. × 400

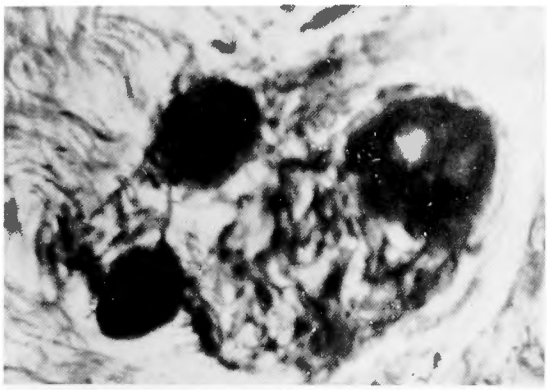

Fig. 25 Degenerated ganglionic cell with a pericellular glomerular body of the nerve fiber (Faserkorb). In this phote fine nerve fiber could not observed. × 1,000

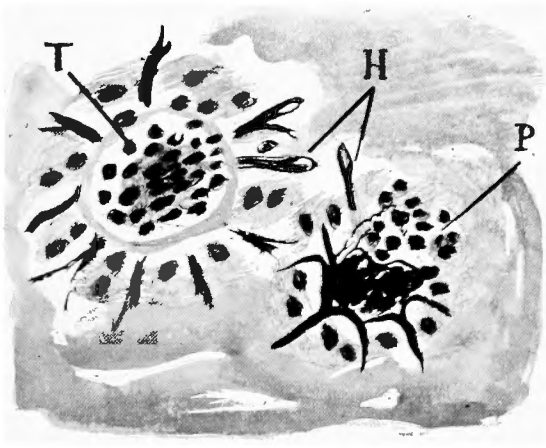

Fig. 26
T)—Terplan's body.
H)—hollow cylinder (Hohlzylinder).
P)—proliferation of satellite cell layer.

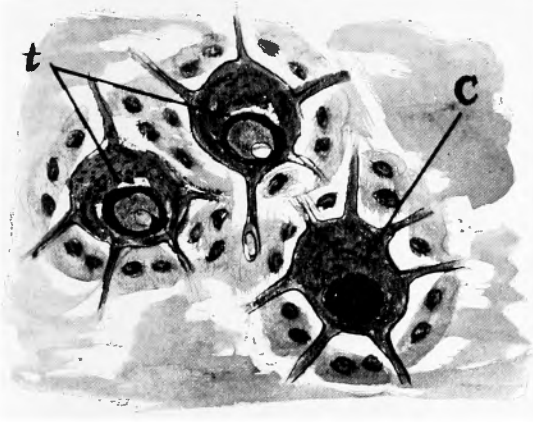

Fig. 27
C)—hyperchromasy of the nucleus.
t)—hypertrophy of the nucleus membrane.

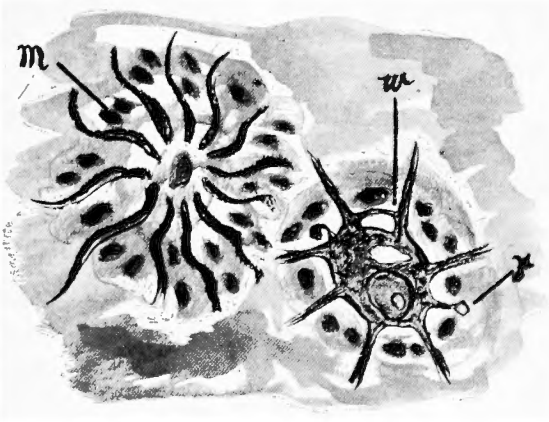

Fig. 28
m)—medusa head (Caput medusae).
w)—fenestrated cell (Fensterbildung).
r)—ring-like degeneration (Ringbildung).

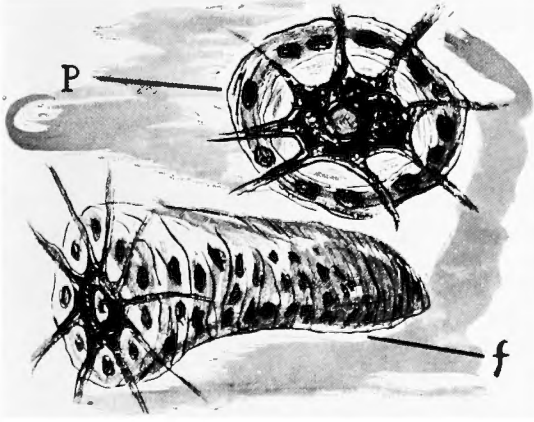

Fig. 29 pericellular glomerular body (Faserkorb).
p)—centripetal. f)—centrifugal.

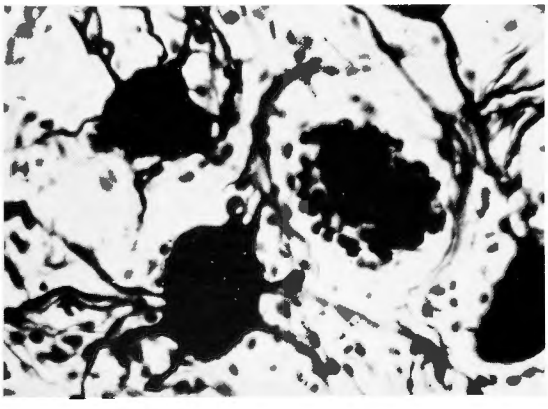

Fig. 30 A rough structure of nerve cell protoplasm.